

MODIS Team Member - Semi-annual Report

Marine Optical Characterizations

June 2003

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NOAA/NESDIS

SUMMARY

Since the launch of NASA's MODIS-Terra and MODIS-Aqua satellites, the Marine Optical Characterization Experiment (MOCE) Team has continued to acquire and provide at-sea observations for MODIS initialization and calibration tasks. The Marine Optical Buoy (MOBY) system has been acquiring optical and basic meteorological observations coincident with Terra and Aqua overpasses in support of the Moderate Resolution Imaging Spectrometer's (MODIS) ocean color mission. In addition, the Team has supplied MOBY derived ocean color data to European and Japanese space agencies for calibration and validation of their MERIS and GLI sensors, respectively.

During this reporting period, the team conducted seven field campaigns in Hawaii in support of the MOBY project. These cruises, designated MOBY- L88 through MOBY- L94, serviced the twenty-first, twenty-second, and twenty-third deployments of the MOBY systems (MOBY221, MOBY222, MOBY223). The Turbid-8 experiment was conducted in the Chesapeake Bay aboard the M/V Lady Bug, providing satellite match-ups and missing variable concentration ranges needed for our algorithm development. The team is continuing to provide the SeaWiFS Project observations for their validation and long-term calibration tasks and to collaborate with NIST personnel in conducting stray-light and temperature characterizations of the MOBY/MOCE optical systems. During this reporting period, we submitted a proposal in response to NASA's announcement NRA-03-OES-02 titled "Earth system science research using data and products from Terra, Aqua, and Acrim satellites". A summary of the team activities during this reporting period is shown in Figure 1.

FIELD OPERATIONS

During **MOBY- L88** (January 10, 2003), Hawaiian Rafting Adventures (HRA) Captain Steve Juarez and his mate sailed to the Lanai mooring site to clean and inspect the MOBY221 optical collectors.

MOBY- L89 occurred January 21 - 30, 2003 aboard the R/V Ka'imikai-O-Kanaloa (KOK). The KOK departed Honolulu, Hawaii on January 21. The MOBY221 was recovered at the north side of Lanai and the Deep-Sea Mooring/Weather Station (LMOB202) were recovered on January 22. The new Deep-Sea Mooring/Weather Station (LMOB202) was deployed on January 23 (Figure 2). We steamed back to shore on the 24th to drop off the old mooring buoy and exchange MOBYs. One bio-optical station was occupied during the first leg of the cruise. The second leg started on the morning of the 25th. The MOBY222 was deployed at the Lanai Mooring site on January 26 (Figure 3). HRA Captain Steve Juarez and his mate assisted Mark Yarbrough with initial diver reference scans on

MOBY222. Three bio-optical stations were occupied during the second leg of the cruise. From the 27th to the 29th, we collected bio-optical algorithm and satellite ocean color product validation match-up data. Thirty-one TSM and 41 POC samples were collected and filtered for analysis. During this cruise, bulk water pigment samples were collected and analyzed, concurrent with MOCE data acquisition. Sixty-seven fluorometric pigment samples were run at sea, with surface values ranging from the usual 0.09 - 0.11 mg m⁻³ near the MOBY site to 0.66 mg m⁻³ inshore, close to the Hilo harbor. Sixty-seven 4-liter HPLC pigment samples were also collected and shipped under LN₂ to CHORS for analysis in San Diego. Twenty-seven samples were collected and analyzed for Colored Dissolved Organic Matter (CDOM) constituents, from the underway flow-through system as well as from 4 CTD rosette casts (Appendix 1). The FOS instrument deployment is shown in Figure 4. All MOBY-L89 pigment data sets were submitted to the MOCE database.

The MOBY mooring recovered during this cruise was close to failure at the upper pear link and shackle. This damage was due to galvanic corrosion caused by the inadvertent grounding of the stainless steel instrument rack to the mild steel buoy frame (Figure 5). The stainless frame has been completely isolated from the buoy and mild steel sacrificial anodes have been added to the stainless frame. Later inspections of the buoy shackles have shown no signs of unusual or excessive corrosion since deployment. This galvanic corrosion also caused pitting of the main buoy frame tube. The lower portion of the buoys must be replaced. This work is in progress at MSI and is due for delivery before the next mooring replacement.

MOBY -L90 occurred March 04 - 06, 2003. The primary purpose of this trip was to calibrate MOBY222 and service the CIMEL instrument. Mark Yarbrough and Terrence Houlihan flew to Maui on March 04 and sailed to the Lanai mooring site on March 05 with HRA Captain Steve Juarez and his mates. They completed one set of “dirty” diver calibrations on MOBY222 and collected two water samples for HPLC analysis. Also, underwater sensor maintenance was performed on LMOB203. One set of “dirty” calibrations and two sets of “clean” diver calibrations were completed on MOBY222, four water samples were collected for HPLC analysis and the CIMEL instrument was serviced on March 06.

MOBY-L91 MOBY replacement cruise occurred April 16 - 18, 2003. The R/V KOK departed Honolulu, Hawaii on the morning of April 16. MOBY223 was deployed and MOBY222 was successfully recovered at the Lanai site on April 18 despite high wind conditions (Figures 6, 7). One bio-optical station was occupied during this cruise. Good satellite in-water/match-up data were collected the same day. Twelve fluorometric samples and HPLC pigment samples were collected for analysis. Fluorometric chlorophyll *a* ranged from 0.07 to 0.08 mg m⁻³ during this cruise. Position, VLST, Chelsea fluorometer, Flow meter, and Thermosalinograph data were recorded and saved for later processing.

During **MOBY- L92** (April 23 - 24, 2003), Mark Yarbrough and Terrence Houlihan flew to Maui and sailed to the Lanai mooring site with HRA Captain Steve Juarez and his mates. They installed flopper-stoppers on MOBY223 and the real-time clock was reset. The CIMEL instrument was serviced on April 24.

MOBY-L93 occurred May 27, 2003. HRA Captain Steve Juarez and his mate sailed to the Lanai mooring site to clean and inspect MOBY223 optical collectors and inspect the Mooring. MOBY's mid-arm was hanging down and some damage to the fiber optic cable channel was found.

During **MOBY-L94** (May 30, 2003), HRA Captain Steve Juarez and his mate sailed to the Lanai mooring site to remove the mid-arm of MOBY223 and to tie-wrap the fiber optic cable channel.

The **Turbid-08** field experiment occurred May 12 - June 02, 2003. The following personnel participated in this experiment:

NOAA - Dennis Clark, Ed Fisher, Eric Stengel, Marilyn Yuen-Murphy
QSS/NOAA - Larissa Koval, Mike Ondrusek
DSTI/NOAA - Yong Sung Kim
MLML - Stephanie Flora
MLML/QSS/Hawaii - Mike Feinholz, Mark Yarbrough
MLML/Hawaii - Terry Houlihan
CIRA/NOAA - Chris Kinkade
University of Miami - Ken Voss

We were able to apply the same small boat technology developed for the University of Hawaii's R/V Klaus Wyrtki to a similar size boat, a 45 foot commercial boat, the M/V Lady Bug (Figure 8). This cruise was unique in that the entire suite of measurements needed to be conducted on a small vessel that had never been used before (Figure 9). This outfitting required several days of fabrication of flow-through runs, instrument platforms and housings, and cabling. Dennis Clark's home basement in Arnold, MD was converted into a wetlab (Figure 10). The M/V Lady Bug was used for daily cruises that departed and returned to Mill Creek's Ferry Point harbor, MD.

Case 2 water algorithm development and validation efforts were somewhat thwarted by inclement weather. Data were collected in and around the Chesapeake Bay from two sampling platforms: the M/V Lady Bug and a dock located in Mill Creek, MD. Due to the weather, shipboard data and accompanying dockside data were collected on only four (May 18 - 20, 27, 2003) of the twelve (May 16 - 27, 2003) scheduled ship days. Two additional days of dockside data collection occurred on May 30 and June 2, 2003. Track lines are shown in Figure 11

Shipboard instrumentation included a SeaBird CTD, a Satlantic MicroPro, a WetLabs AC-9, a Chelsea fluorometer, a Raymarine wind system, an ROV, a MOS/SIS system, and the NuRADS system. The ROV thrusters were upgraded prior to the Turbid-8 experiment. The new brushless motors provide about 50% more thrust in the horizontal than the old motors. The improvement in the vertical is about 25%. MOS202 was re-configured (cfg10) to accept fiber-optic inputs to both the UP (Lu) and DOWN (Ed) end-cap ports. The UP port was cabled to an underwater radiance (Lu) collector on the new ROV. The DOWN port was cabled to an above-water surface - incident irradiance (Es) head, which was mounted aboard the boat next to SIS101 Es. The ROV platform was

radiometer independent so changing from the FOS to the MOS radiometer had no effect on ROV operability. The only difference in station operations was the reduced signal integration time and shorter “on station” time when using MOS. Figures 12 and 13 show the ROV operations. The underwater radiance distribution system (NuRADS) was also utilized during this trip. This instrument worked well and provided a large data set that will be used to characterize the underwater radiance light field in a variety of water types. Figure 14 shows NuRADS system deployed during bio-optical station. Processing of the NuRADS data, which were collected while on-station, is in the preliminary stages.

Forty-six CTD and 136 MicroPro casts were performed during the four days at sea. Figures 15 and 16 depict SeaBird CTD housing and deployment. The CTD data have been preliminarily processed and the MicroPro data processing has been completed. The AC-9 (beam transmission and absorbance) and fluorometer data were collected in trackline mode to detect horizontal features, and both of these data sets are in the preliminary stages of data processing. The wind system data sets (wind speed and direction, ship’s heading, time, and position) were collected continuously whenever the boat was at sea. Data processing on these data sets has not yet commenced. MOS observations were typically collected at four depths (0.1, 0.25, 0.5, and 1 m) at each station using fibers that were deployed by the ROV. SIS data were also collected concurrent with the MOS observations. Radiometric data (MOS and SIS) processing for Turbid-8 is nearly complete. Stations 1 - 6 have been completely processed while stations 7 - 15 have only been preliminarily processed.

Water samples for pigment concentration, particle size distribution, TSM, POC, CDOM, and particulate/detrital absorption analyses were also collected aboard ship at each station. Pigment samples, both fluorometric (67 samples) and HPLC (62 samples), were pressure filtered while at sea. Despite many days of foul weather and clouds, we sampled a large dynamic range of pigment concentrations during this experiment; samples ranged from 3.3 to 133 mg m⁻³ chlorophyll *a*. These experiments enabled the bio-optical characterization of “green” water in contrast to the “blue” water we normally encounter in Hawaii. Ninety particle size distribution water samples were collected and analyzed by a Spectrex particle counter on the M/V Lady Bug as well. A calibration experiment will be conducted in Hawaii in order to complete Turbid-8 particle size distribution processing. The TSM (24 samples), POC (24 samples), CDOM (17 samples), and particulate/detrital absorption (15 samples) were collected in LDPE Nalgene bottles and stored on ice for sample processing at the end of each day at the Mill Creek dock facility.

Specialized instrument shadowing experiments were performed at the Mill Creek dock using the FOS with fibers (Figure 17). A total of six shadowing experiments, along with nine bare fiber profiles, were performed during Turbid-8. Data processing has commenced for all FOS data. Concurrent with the FOS measurements, TSM (16 samples), POC (16), CDOM (16), particulate/detrital absorption (15), fluorometric pigments (12), and HPLC (12) water samples were collected. In addition, an AC-9 was run continuously during dockside data collection, and CTD profiles were collected dockside on May 30 and June 2. The dockside AC-9 and CTD data sets are in the preliminary stages of data processing.

All of the fluorometric pigment samples (shipboard as well as dock side) have been analyzed and are ready for incorporation into the pigment data table in the ocean color database. The HPLC

samples were shipped in liquid nitrogen to CHORS for analysis, and the TSM and POC samples were shipped to MLML for analysis as well. The particulate/detrital absorption samples were analyzed on a Perkin-Elmer Lambda-45 spectrometer and data processing is nearly complete for this data set. The CDOM water samples were analyzed on the Perkin-Elmer Lambda-45 and the World Precision UltraPath spectrometers, and intercomparison of the CDOM absorption spectra is underway.

RADIOMETRIC STANDARDS & RADIOMETERS

Team personnel stationed at the NOAA operations facility at Snug Harbor, Hawaii continued maintenance of our NIST-traceable radiometric standards and performed calibrations of our radiometers. The MLML OL420 and OL425 radiance standard spheres were sent to NIST for post-calibration on their lamps, after which they were re-lamped and re-calibrated at NIST. Lamp #07 in the OL420 was pre-calibrated by NIST on August 12, 2002, and as of the end of June, it had provided 15.2 hours use. The OL425 Lamp #04 was pre-calibrated at NIST on August 9, 2002 and as of the end of March, it had provided 24.4 hours use. The status of these new calibrations was reviewed by M. Feinholz and B.C. Johnson during the NIST-2003-01 intercomparison work with NIST in March. At the end of June 2003, the following summary of calibration sources can be reported: the F453 FEL irradiance standard had 42.6 hours use since its July 1998 NIST calibration; F454 had 21.5 hours on a February 2001 calibration; and F471 had 24.7 hours service since its February 2001 calibration.

In June, M. Feinholz received drafts of the SIMRIC-2 report (NASA/TM-2003) from Gerhard Meister at SIMBIOS (Sensor Intercomparison and Merger for Biological and Interdisciplinary Oceanic Studies) detailing measurements made in August 2002 at NIST. Gerhard compared SeaWiFS Transfer Radiometer (SXRII) “measured” radiance of MLML OL420 and OL425 with “expected” radiances from NIST FASCAL (August 07, 2002, before re-lamping). The measured/expected differences for the MLML spheres (at two intensity-settings each) were 2% or less, and the OL420 agreed better than 0.8% to day-before NIST NPR radiance, which are within the combined uncertainties of the SXRII at NIST. Also, repeated measurements after setup and startup agreed better than 0.1%. These experiments showed that of ten participating laboratories, only two had measured/expected radiances outside the range of combined uncertainties. Likely error sources were identified and corrective measurements were implemented at those laboratories.

The yearly NIST/MLML Calibration Inter-Comparison took place between March 20 - 27, 2003 (NIST-2003-01) when NIST researcher B.C. Johnson and M. Feinholz conducted experiments at the Snug Harbor Hawaii site. The MLML OL420 and OL425 and NIST NPR Radiance standards were measured repeatedly via NIST VXR and NOAA SLM radiometers. Results were examined by comparing “Predicted” to “Measured” signals. Predicted signals are the integral of the absolute radiance responsivities times the most-recent-calibration spectral radiance values for the integrating spheres. The radiance responsivities are from the December 2001 NIST SIRCUS measurements for the VXR and the September 2002 results for the SLM from SIRCUS. The NPR spectral radiance values come from the March 6-7, 2003 NIST FASCAL measurements and the MLML spectral radiance values come from the August 2002 FASCAL measurements. In most cases, the measurement sequence was VXR - SLM - VXR, then change sphere/level.

During NIST-2003-01, the SLMs and the VXR measured the NIST Portable Radiance source (NPR) at three levels on March 24 and repeated these measurements on March 25. The SLM results agree within +/- 2%, but the VXR channel 1 appears to be an outlier. Measurements of the OL420 and OL425 spheres were made on March 22 and repeated on March 25; aperture-wheel settings W4, W5, and W6 were measured for the OL420. Results for the measurements of the NIST shunt agreed within the digitization limits of the equipment. B. C. Johnson planned to investigate VXR blue channel anomalies upon her return to NIST. We received a preliminary NIST trip report in March.

Calibrations were performed for MOS202/ROV on Lu and Ed in April/May before shipping the instruments from Hawaii to Maryland for absolute response, wavelength response, and preliminary stray-light response (Appendix 2). "Preliminary" stray-light response consisted of viewing the MLML green (514.5 nm) and red (632.8 nm) HeNe Lasers and comparing with earlier SIRCUS measurements. In-Band and reflection-peak signals were similar between pre- and post-ROV configurations (cfg09 and cfg10), so we hope to be able to apply earlier SLC parameters to the MOS202/ROV data. During Turbid-8 rain-out days in May, B. C. Johnson brought NIST lasers, a Deuterium lamp, and filters to the dock for more stray-light response calibrations on MOS202. These data are being processed/evaluated by S. Flora (MLML) and S. Brown (NIST). One preliminary result is a satisfactory application of temperature characterization from MOS204 (December 2002, NIST-2002-06) to MOS202: Pre-Turbid-8 MOS202 Lu response via OL420 in Hawaii (TT7 approximately 30°C) agreed with OL420 Lu response aboard the boat in Maryland (MOS202 on ice, TT7 approximately 13°C) after applying a temperature correction of about 8.6%.

Radiometric calibrations during the reporting period included:

1. January 2003 Pre-MOBY-L89 MOS202 and SIS101, Pre-Deployment MOBY222
2. February 2003 Post-Deployment MOBY221 and MOS205
3. March 2003 Post-MOBY-L89 MOS202 and SIS101
4. April 2003 Pre-Turbid-8 MOS202/ROV and Pre-Deployment MOBY223
5. May 2003 Pre-Turbid-8 MOS202/ROV and SIS101. Post-Deployment MOBY222 and MOS204, During Turbid-8 MOS202/ROV
6. June 2003 Post Turbid-8 MOS202/ROV and SIS101, and MOS204

A detailed listing of calibrations and maintenance for each standard and instrument are provided in Appendix 2.

STRAY LIGHT/TEMPERATURE CHARACTERIZATION

Preliminary results from the first MOS temperature characterization experiments in December 2002 (NIST-2002-06) have been derived and the final NIST report has been received (NIST-2002-06-TR). A spectrally-averaged temperature dependance for the MOS204 blue spectrograph of about 0.44% increase of ADU/pix/sec per degree Celsius rise at the internal TT7 computer, and about 0.53% change per degree for the red spectrograph, were observed. Of the eight thermistors monitored inside MOS, temperatures from the TT7 computer and the Blue CCD head had the lowest variance for a three-point linear regression between delta-ADU/pix/sec and delta-temperature: the TT7 was

about 0.15% and the head about 0.02%.

Although this experiment needed to be repeated for MOS204, and conducted for the first time on the profiler MOS202 and the odd-numbered MOBY radiometer MOS205, some conclusions can be drawn regarding the type of corrections that will need to be applied to our MOS/MOBY field measurements. Historical pre-deployment MOS204/MOBY2xx laboratory calibrations have internal TT7 temperatures averaging about 30 degrees Celsius with a change of about 4°C during the suite of Eu/Ed/Lu measurements. MOBY's internal TT7 temperature during an at-sea measurement "suite" (i.e. Surface, Top, Middle, Bottom, MOS position) are on average about 32°C with a maximum range of about 4°C. Each at-sea measurement would therefore be corrected by calculating the difference in temperature from the sensor's laboratory pre-calibration, then adjusting the spectra by about one half percent per degree. For the average temperatures above (30°C lab, 32°C sea), this would yield a 1% adjustment - decreasing the at-sea Eu/Ed/Lu spectra across all wavelengths. The recompilation of the historical MOS/MOBY calibration database has begun, and the data processing procedures have been modified to implement this type of temperature correction.

NIST researcher S. Brown traveled to Moss Landing in April to work with S. Flora to finish the MOS profiler stray-light correction (SLC) which began in December 2002. They finished the SLC (version 2) for the MOS profiler, including off-CCD and a spectrally variable correction for the red spectrograph. An SLC was also developed, but not applied, to the blue spectrograph. Haze and reflection peak data were normalized using the procedure developed during the NIST-2002-06 experiment in December 2002 and refined during this trip. The MOCE-5 data set was stray-light corrected and the effects of the algorithm on green and blue waters was noted. The uncertainties in the SLC were checked using a Monte-Carlo simulation. S. Flora and S. Brown spent a significant amount of time documenting each step in the process. The documentation is nearly finished.

MOCE/MOBY INSTRUMENTATION

MOBY

Problems with MOBY's middle arm were discovered in May during the Turbid-8 field campaign. We began to notice problems with the top and mid-arm Lu observations (Lu top was flat-lined, and the Lu and Ed mid values were low). HRA divers confirmed the mid-arm was severely damaged (underwater pictures shown in Figures 18 and 19). The support bracket had penetrated the fiber optic channel breaking the Lu top fiber. MOBY measurements were limited to Lu bottom, which meant that Kl could not be computed. Typically, the Kl's computed from the top and mid Lu's are used in the Lwn matchup data base. Since MOBY would not be replaced until July, an approach was adopted using a monthly mean Kl for propagating the Lu bottom observations to the surface. A 5 year monthly mean value was calculated for each MOBY hour and the mean Kl was used to propagate the Lu bottom observations to the surface. These Lwn's computed from the Lu bottom observations will be available in MOBY's gold directory as Lw10.

The loss of the mid-arm on MOBY223 has forced us to take a look at ways to better protect the fibers where they run through the fiber channel under the arm bases. Better positioning and securing

of the fibers in the channel may help to prevent this type of damage. In addition, the new arm bases, now in fabrication, are of a new stronger design and should not bend or break at the base at a location where they can damage the fiber

Mooring Systems is in the process of fabricating replacement collector standoff and clamp components. One of the new arms was deployed during the MOBY222 deployment. Based upon this successful evaluation, the new sets of standoff assemblies are being completed at MSI. We are expecting a full set for the MOBY224 deployment in July.

MOS

There are currently no pressing maintenance issues with the operational MOS2 instrument. MOS units 1, 4, and 5 are fully functional and receive periodic maintenance consisting of CCD head evacuation and coolant pump service. MOS2-1 was fitted with 90° radiance fiber optic heads for use with the ROV/Fiber optic collection platform. Adapter plates were fabricated to allow attachment of MOBY radiance heads to act as fiber optic input optics. These “adapter” heads allow attachment of an Es collector to the “down” MOS port and the long ROV Lu fiber to the “up” port. The heads and adapter plate spaces are purged and desiccated to prevent condensation when the MOS is on ice while making measurements. The initial stray-light checks of this configuration indicated that a full set of laser measurements would be needed to adequately characterize the MOS stray-light error. The history of MOS observations during this reporting period is shown in Appendix 3.

FOS

During the Turbid-8 cruise, the shadowing experiments were conducted using the FOS instrument. A housing for FOS was constructed with PBC pipe. The PBC pipe was fastened with 2 bolts to a 9 foot ladder. The FOS was held in an upright position by 3 bolts with 2 cutout forms. The Es measurements were taken before, during, and after the bare fiber casts and shadowing measurements.

WEATHER STATION

The third Mooring Weather Station (LMOB203) was rebuilt and all of the underwater instrumentation are fully functional. The quality of the data continues to suffer due to multiple fouling sources. The fluorometer and transmissometer data show fouling events on the order of 1 to 2 weeks, which is much more frequent than our 1 - 2 month MOBY cleaning trips. The mooring optics variations do not seem to track the variation we see in the MOBY measurements. Improving this situation may require different instrumentation. Work continues in testing the Iridium Satellite phone telemetry of meteorological station data.

CIMEL SERVICE

The Lanai CIMEL system continues to deteriorate and is due for recalibration. Aeronet plans to replace the system in September 2003. The Coconut Island CIMEL instrument was replaced in March at Aeronet's request because the radiometer signal was degrading at a rapid speed. The old

unit, #162, was removed on March 16 and the new unit, #151, was installed on April 21. The CIMEL instruments continue to receive monthly cleanings.

MICROPRO

Stability of the MICROPRO and MICROREF instruments have continued to be monitored using the Gamma Scientific RS10 lamp system. The MICROPRO was sent to Satlantic for new calibrations in June

ROV

The ROV thrusters were upgraded prior to the Turbid-8 experiment. More improvement is expected when the new 600 watt Vehicle Power Supply is installed. The Vehicle Power Supply and associated 1000 watt Surface Power Supply have been delivered and are awaiting installation, which is expected before the next Honolulu Klaus Wyrski cruises. The ROV upgrades provided noticeable improvement in depth control during the Turbid-8 experiment. MOS was integrated with the ROV system and used during the Chesapeake Bay cruise.

DATA PROCESSING

MODIS CALIBRATION AND VALIDATION

After the Turbid-7 cruise in the Fall of 2002, we were able to significantly improve our ocean color satellite product algorithm. In addition to increasing the number of data points in each algorithm, we were able to tighten the relationship in the mid to high chlorophyll waters where our previous algorithm versions were under sampled. We also relaxed the forcing for the clear water radiance ratio that was used in previous versions. As a result, all of our five MODIS product algorithms have been fitted to a 5th order polynomial equation (Figure 20). These new formulations of the algorithm were incorporated into the MODIS processing in the beginning of March. The MODIS ocean science team is continuing to utilize MOBY data as a vicarious calibration source for the Terra and Aqua satellites. In addition, we have supplied MOBY derived ocean color data to the European and Japan space agencies for calibration and validation of their MERIS and GLI sensors, respectively. The new plot for the MODIS F490 product validation, validating against SeaWiFS K490 product with daily global data, is depicted in Figure 21. The agreement was generally good, with SeaWiFS having ~ 10% higher values.

MOBY/MOS/SIS

MOBY now acquires three files a day, coincident with the SeaWiFS and the two MODIS overpasses. MOBY acquisition times are 20:40 (Aqua), 22:47 (SeaWiFS), and 00:10 (Terra) GMT. MOBY only transmits two files (MODIS Aqua and Terra) each day. The SeaWiFS files are downloaded at the end

of the deployment and processed. MLML personnel process the 20 and 23 hour files the following day. All files are weighted to MODIS and SeaWiFS bands.

In the middle of March, MLML personnel began working on programs to answer the “what if” questions about MOBY data. For example, what is the effect of using a 5 year monthly mean K_L to calculate the water leaving radiance? What is the effect of applying the cosine of the refracted solar zenith angle to K_L calculations? What is the effect of using a mean file time to calculate the solar normalizing factor verses using the time the data were collected? These questions were addressed as part of our response to the NASA Research Announcement. The result was a change in the calculation of the solar normalizing factor. Previously, we used a mean file time and calculated one solar normalizing factor for all the radiances in the file. The new procedure uses the time the radiance data were collected, which results in a solar normalizing factor for each radiance. All MOBY data were reprocessed and the new data were put on the web in March.

MOBY CONTRACTS

The Hawaiian Rafting Adventures contract was renewed as of May 1st. This contract is 12 months long under the same terms as the previous contract.

A new contract was submitted for CHORS pigment analyses. This is a 12 month long contract in which CHORS will provide analysis of our collected pigment samples. CHORS will use a fluorometric and an HPLC technique for these analyses.

The University of Hawaii shore support contract remains in place with all terms and conditions unchanged.

MEETINGS

Dr. Christopher Kinkade traveled to Oregon State University to attend the NOAA site visit at the Cooperative Institute for Oceanographic Satellite Studies at the College of Oceanic and Atmospheric Sciences. He gave a presentation on current and future NOAA ocean color operations, products and research (May 12 - May 15).

2003	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
January										L 88																					
February																															
March																															
April																															
May																															
June																															

Figure 1



Figure 2

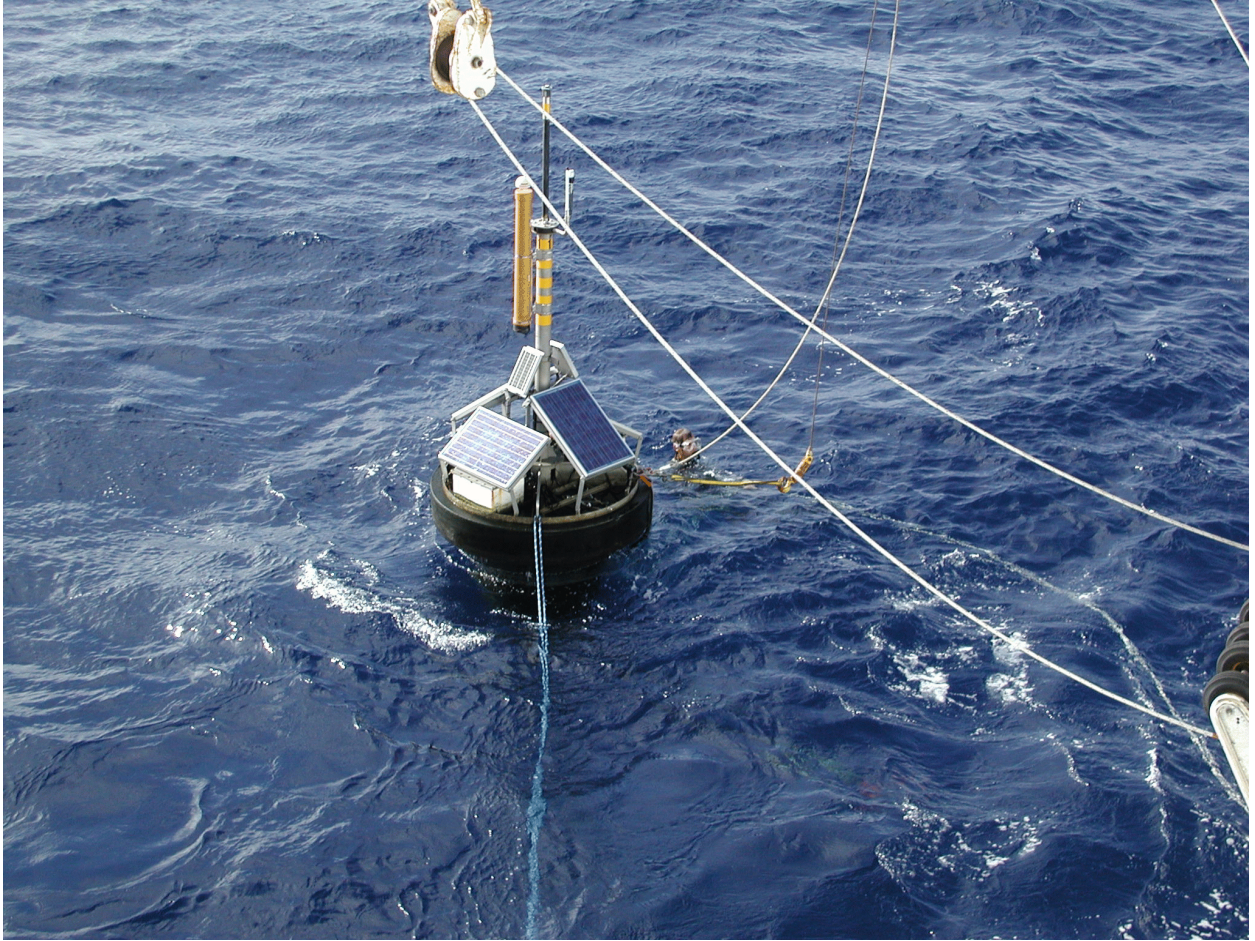
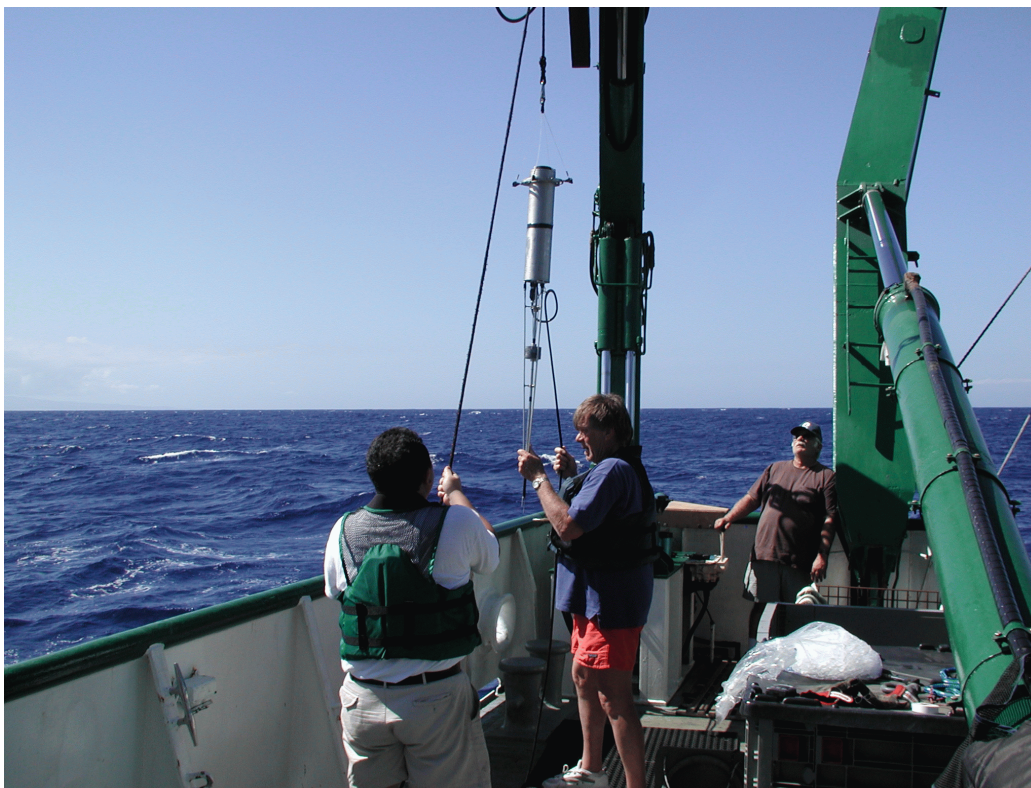


Figure 3



Figure_4



Figure 5



Figure 6



Figure 7



Figure 8



Figure 9



Figure 10

18 to 27-May-2003 : Turbid-08 , Chesapeake Bay , Track Lines (26Jun03 MF)

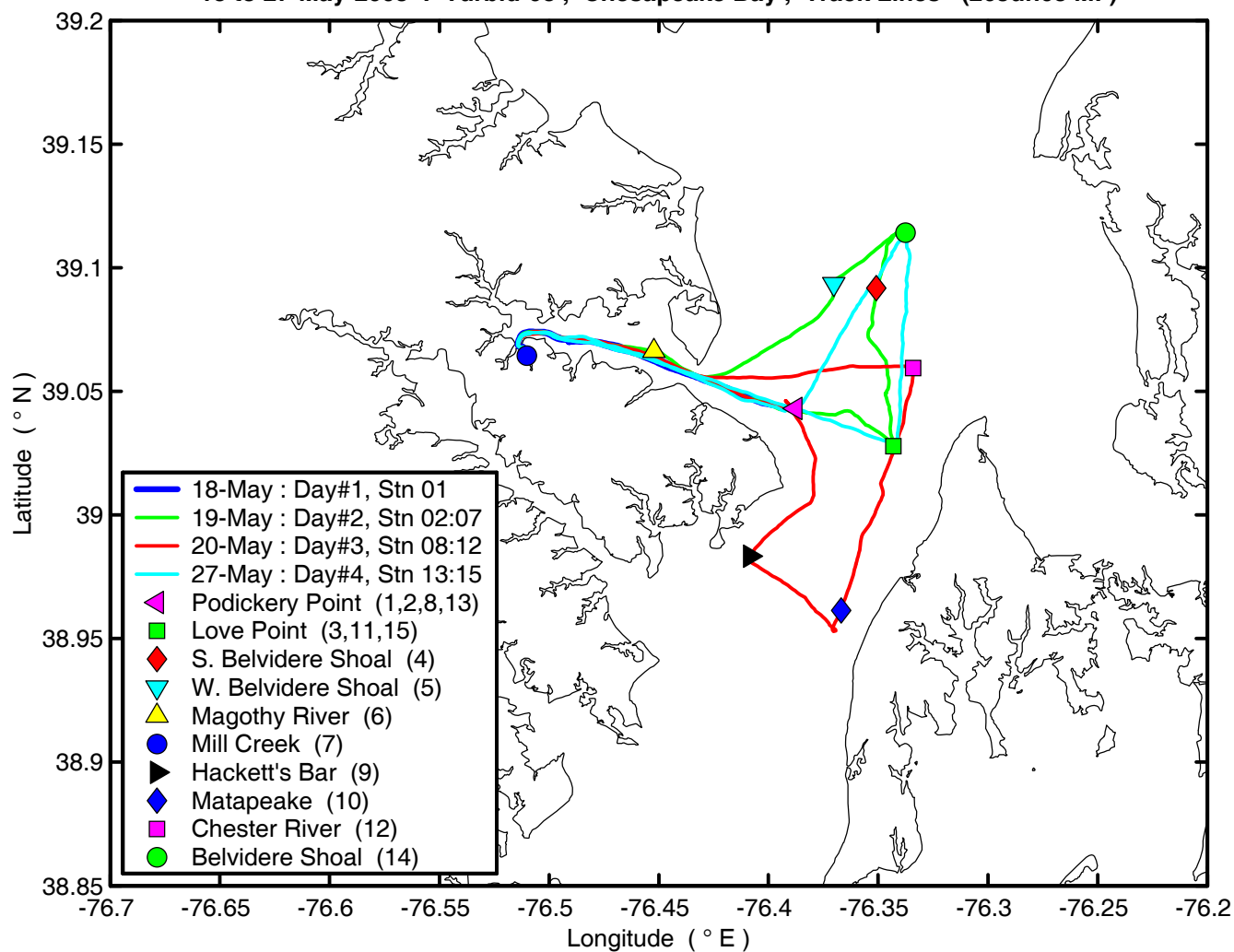




Figure 12

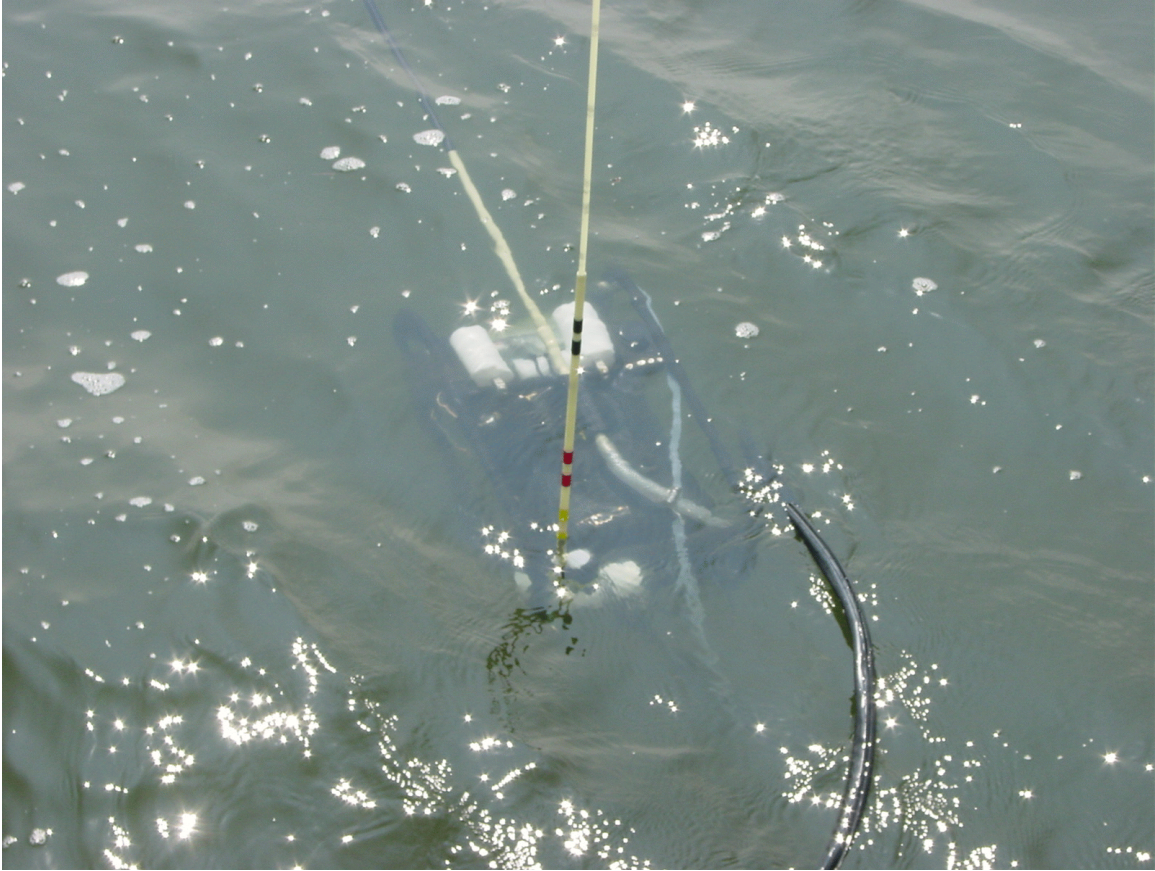


Figure 13



Figure 14

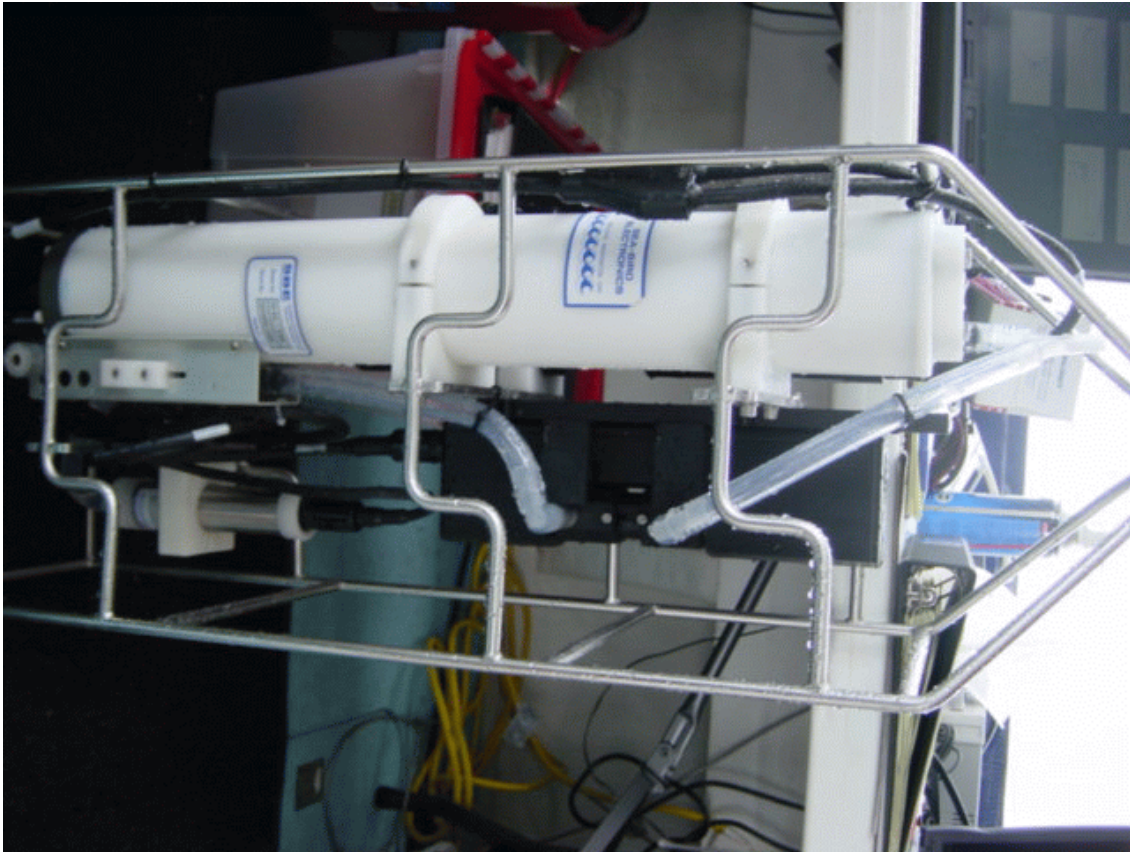


Figure 15



Figure 16



Figure 17



Figure 18

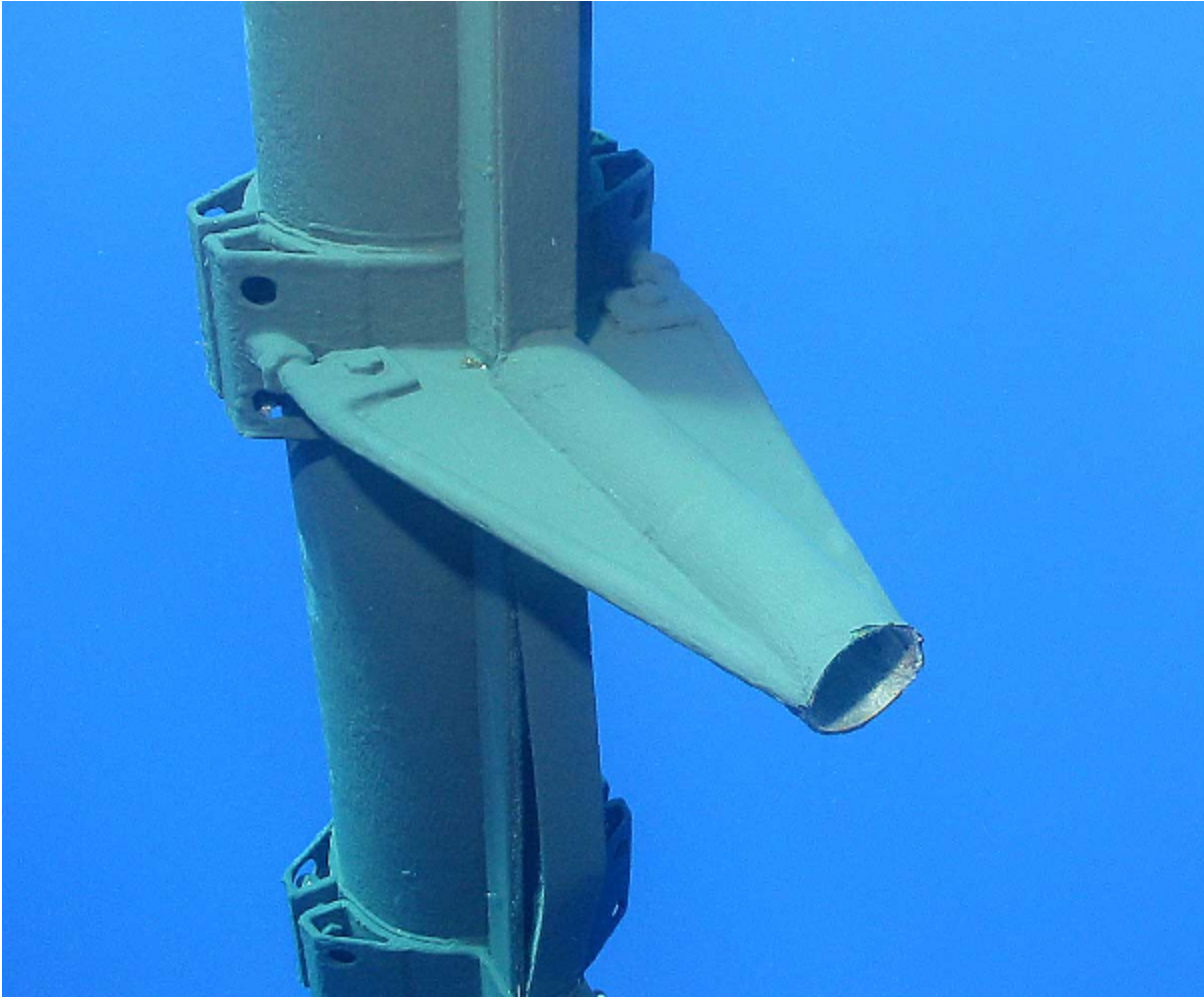
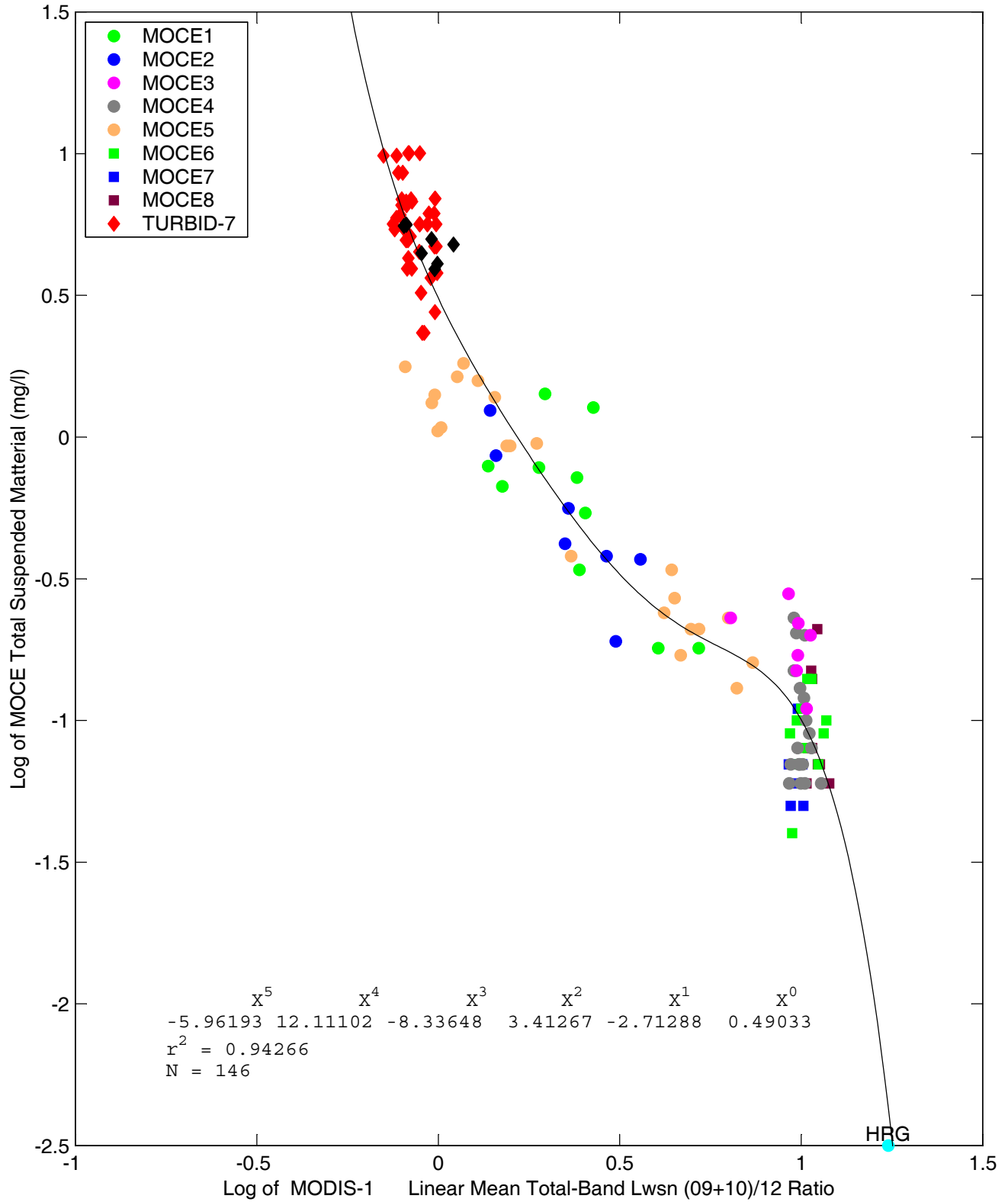
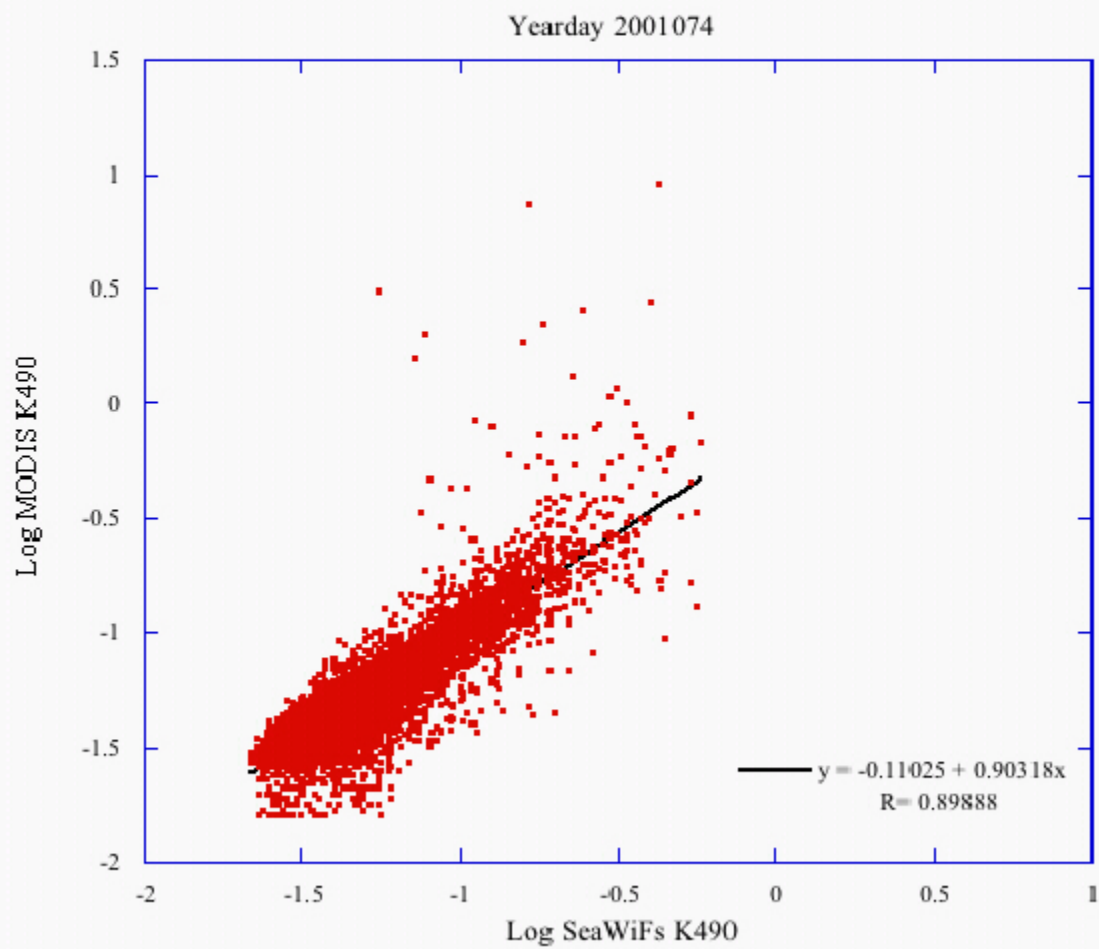


Figure 19

Total Suspended Material MODIS-Terra





Figure_21

Appendix 1: History of Seabird CTD Observations.

MOBY-L89 SeaBird CTD Stations

Station	Position	Date (GMT)	Filename	Max. Depth
02, Super Bowl XXXVII	20° 50.80'N 157° 09.74'W	19:35 (GMT) 26 Jan 2003	sbe0158p.mld	205
03, Waipio Bay	20° 21.35'N 155° 30.97'W	21:05 (GMT) 27 Jan 2003	sbe0159p.mld	205
04, Ale Nui Haha Channel	20° 26.53'N 155° 59.80'W	19:23 (GMT) 28 Jan 2003	sbe0160p.mld	205
04, Ale Nui Haha Channel	20° 29.52'N 155° 56.78'W	01:24 (GMT) 29 Jan 2003	sbe0161p.mld	204

Appendix 2: Calibrations and maintenance schedules for MLML standards and instruments

• SLM

16-Jan-2003	Pre-L89	OL425-W6D100 after MOS202c09
17-Jan-2003	Pre-L89	GS5000-F453 after MOS202 & SIS101
19-Jan-2003	Pre-L89	OL425-W6D100 after MOBY222 Lu Pre-Cal
21-Jan-2003	Pre-L89	GS5000-F471 after MOBY222 Eu/Ed Pre-Cal
23-Jan-2003	Pre-L89	OL425-W6D100 after MOBY222 LuB,M,T Pre-Cal
24-Jan-2003	Pre-L89	OL425-W6D100 after MOBY222 LuM,T Pre-Cal
20-Feb-2003	Post-L89	OL425-W6D100 after MOBY221 Lu Post-Cal
22-Feb-2003	Post-L89	GS5000-F471 after MOBY221 Eu/Ed Post-Cal
28-Feb-2003	Post-L89	OL425-W6D100 after MOS205c08
03-Mar-2003	Post-L89	OL425-W6D100 after MOS202c09
19-Mar-2003	Post-L89	GS5000-F453 after MOS202 & SIS101
22-Mar-2003	NIST-2003-01	NPR-x4/03/02
23-Mar-2003	NIST-2003-01	OL425-W6D100
23-Mar-2003	NIST-2003-01	OL420-W4/W5D100
25-Mar-2003	NIST-2003-01	OL420-W4/W5/W6D100
26-Mar-2003	NIST-2003-01	OL425-W6D100
26-Mar-2003	NIST-2003-01	NPR-x4/03/02
03-Apr-2003	Pre-L91	OL425-W6D100 after MOBY223 Lu Pre-Cal
05-Apr-2003	Pre-L91	GS5000-F471 after MOBY223 Eu/Ed Pre-Cal
10-Apr-2003	Pre-L91	GS5000-F471 after MOBY223 EdBot Pre-Cal
30-Apr-2003	Pre-Turbid08	OL425-W6D100 after MOS202/ROV Lu/Es
30-Apr-2003	Pre-Turbid08	OL420-W5D100 after MOS202/ROV Lu/Es
01-May-2003	Pre-Turbid08	GS5000-F453 after MOS202/ROV Es & SIS101
07-May-2003	Post-L91	OL425-W6D100 after MOBY222 Lu Post-Cal
08-May-2003	Post-L91	GS5000-F471 after MOBY222 Eu/Ed Post-Cal
09-May-2003	Post-L91	OL425-W6D100 after MO204cfg06 Lu
14-Jun-2003	Pre-L95	OL425-W6D100 after MO204cfg07 Lu
24-Jun-2003	Pre-Oahu04	OL420-W5D100 before NuRADS (K.Voss/UMiami)
28-Jun-2003	Post-Oahu04	OL420-W5D100 before NuRADS (K.Voss/UMiami)

• SIS101

19-Mar-2003	Post-L89	GS5000-F453, HgA, Ne via Es cfg04
01-May-2003	Pre-Turbid08	GS5000-F453, HgA, Ne via Es cfg04

• MOS202

15-Jan-2003	Pre-L89	OL425-W6D100 via UP Lu cfg09
17-Jan-2003	Pre-L89	GS5000-F453 via DN Ed cfg09
18-Jan-2003	Pre-L89	HgA, Ne, Kr, Xe via DN Ed cfg09
03-Mar-2003	Post-L89	OL425-W6D100 via UP Lu cfg09
19-Mar-2003	Post-L89	GS5000-F453 via DN Ed cfg09
19-Mar-2003	Post-L89	HgA, Ne, Kr, Xe, Ar, HgNe via DN Ed cfg09
01-Apr-2003	Cfg10	Remove cosine collector For ROV fiber mounts

30-Apr-2003	Pre-Turbid08	OL425-W6D100 via ROV Lu/Es/fibers/head
30-Apr-2003	Pre-Turbid08	OL420-W5D100 via ROV Lu/Es
01-May-2003	Pre-Turbid08	GS5000-F453 via ROV Es
01-May-2003	Pre-Turbid08	HeNe 514 & 632 + spectralon via ROV Lu/Es
02-May-2003	Pre-Turbid08	HgA, Ne, Kr, Xe via ROV Lu/Es
17-May-2003	Pre-Turbid08	OL420-W5D100 via ROV Lu fiber #1 (in MD)
21-May-2003	Dur-Turbid08	OL420-W5D100 via ROV Lu fiber #2 (in MD)
22-May-2003	Dur-Turbid08	NIST Lasers via ROV Lu fiber #2 (in MD)
23-May-2003	Dur-Turbid08	NIST D2 & HgA + filters via ROV Lu fiber #2 (in MD)

• MOS204

Jan/Feb/Mar	NA	Deployed via MOBY222
09-May-2003	Post-L91	OL425-W6D100, HgA, Ne, Kr, Xe via UP Lu cfg06
14-Jun-2003	Pre-L95	OL425-W6D100, HgA, Ne, Kr, Xe via UP Lu cfg07

• MOS205

28-Feb-2003	Post-L89	OL425-W6D100, HgA, Ne, Kr, Xe via UP Lu cfg08
Apr/May/Jun	NA	Deployed via MOBY223

• MOBY221

20-Feb-2002	Post-L89	OL425-W6D100 via LuB,M,T < Post-Cal
22-Feb-2002	Post-L89	GS5000-F471 via Eu,EdB,M,T,S < Post-Cal

• MOBY222

19-Jan-2003	Pre-L89	OL425-W6D100 via LuB,M,T < Pre-Cal
21-Jan-2003	Pre-L89	GS5000-F471 via Eu,EdB,M,T,S < Pre-Cal
23-Jan-2003	Pre-L89	OL425-W6D100 via LuB,M,T < Pre-Cal #2
24-Jan-2003	Pre-L89	OL425-W6D100 via LuM,T < Pre-Cal #3
07-May-2002	Post-L91	OL425-W6D100 via LuB,M,T < Post-Cal
08-May-2002	Post-L91	GS5000-F471 via Eu,EdB,M,T,S < Post-Cal

• MOBY223

03-Apr-2003	Pre-L91	OL425-W6D100 via LuB,M,T < Pre-Cal
05-Apr-2003	Pre-L91	GS5000-F471 via Eu,EdB,M,T,S < Pre-Cal
10-Apr-2003	Pre-L91	GS5000-F471 via EdB < Pre-Cal #2

Appendix 3: History of NOAA/MLML Marine Optical System (MOS) Observations.

Cruise: MOBY-L89, Ship: R/V Ka'imika-O-Kanaloa, Location: Hawaii (MOS202cfg09)

Station (# Name)	Date (GMT)	Time (GMT)	Latitude (+North)	Longitude (+East)	Depths (dbar)
01 MOBY Mooring I	23-Jan-2003	NA	20.815	-157.200	NO MOS
02 MOBY Mooring II	26-Jan-2003	NA	20.815	-157.200	NO MOS
03 Waipio Bay	27-Jan-2003	23:27	20.365	-155.507	1,5,9
04a Alenuihaha Channel	28-Jan-2003	21:14	20.499	-155.965	1,5,9
04b Alenuihaha Channel	29-Jan-2003	00:04	20.496	-155.954	1,5

Cruise: Turbid-08, Ship: Lady Bug, Location: Chesapeake Bay, MD (MOS202cfg10)

Station (# Name)	Date (GMT)	Time (GMT)	Latitude (+North)	Longitude (+East)	Depths (dbar)
01 Podickery Point I	18-May-2003	16:45	39.043	76.389	.1,,5,1
02 Podickery Point II	19-May-2003	13:39	39.043	76.389	.1,,3,,5,1
03 Love Point I	19-May-2003	15:07	39.028	76.342	.1,,3,,5,1
04 South Belvidere Shoal I	19-May-2003	16:33	39.092	76.351	.1,,3,,5,1
05 West Belvidere Shoal I	19-May-2003	17:44	39.093	76.370	.1,,3,,5,1
06 Magothy River I	19-May-2003	18:01	39.066	76.452	.1,,3,,5,1
07 Mill Creek I	19-May-2003	20:01	39.064	76.510	NO MOS
08 Podickery Point III	20-May-2003	13:28	39.044	76.390	.1,,3,,5,1
09 Hackett's Bar I	20-May-2003	15:04	38.983	76.408	.1,,3,,5,1
10 Matapeake I	20-May-2003	16:28	38.961	76.367	.1,,3,,5,1
11 Love Point II	20-May-2003	17:53	39.028	76.342	.1,,3,,5,1
12 Chester River I	20-May-2003	18:56	39.059	76.334	.1,,3,,5,1
13 Podickery Point IV	27-May-2003	14:37	39.043	76.389	.1,,2,,3,,5,1
14 Belvidere Shoal I	27-May-2003	16:27	39.114	76.337	.07,,3,,5,1
15 Love Point III	27-May-2003	18:11	39.028	76.341	.07,,2,,3,,5,1